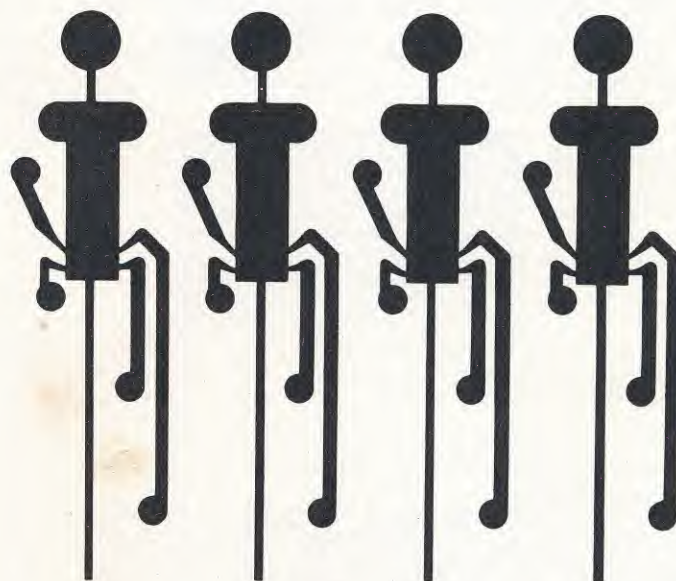


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A 2 OPERATED DISPLAY

Fluidics

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by

Robert F. O'Keefe

Manager, Fluidics Technology

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Pitney-Bowes
Fluidic Controls

AIR OPERATED DISPLAY — FLUIDICS

Robert F. O'Keefe
Pitney-Bowes Fluidic Controls
Research Drive
Glenbrook, Connecticut 06906

Abstract

The young technology of fluidics has begun to produce display components compatible with system requirements for industrial control. These display devices have excellent viewing characteristics and can be produced in a wide range of sizes suitable for small panels or wall sized information systems. This paper describes the principles of operation of air operated displays and their characteristics, fluid logic, and the areas of application for these displays.

Introduction

Air actuated display devices have recently been developed, and additional devices are in process, as a consequence of the young technology of fluidics. Fluidics is finding its niche in industrial controls. Components required to implement a complete fluidic control system are now commercially available at attractive prices, and these include air operated indicators and readouts which have been developed especially for fluidic control systems.

Now that a representative number of indicators and readouts are available, and considerable experience with them is being accumulated, it is worthwhile to consider the possibility of extending their use to display systems outside of the industrial control market. These air operated readouts have the advantage of a new appearance, excellent contrast, wide range of character size, wide viewing angle, freedom from electro-magnetic interference, and capability to operate safely in hazardous environments.

Type of Display

Air operated indicators and readouts which are presently marketed use a mechanical motion to change the position of an indicating surface. Among the various indicator types are (a) pistons and spheres, which are positioned by air signals alone or in concert with a spring action; (b) rotating elements actuated through a linkage; and (c) indicating surfaces which can be immersed in, and withdrawn from, an opaque liquid.

The simple all air operated indicator shown in Figure 1 uses low pressure air signals to drive a piston into and out of the field of view. An air signal applied at the center connection drives the white or colored piston into a transparent enclosure where it is visible through a wide viewing angle. The indicator is retracted by an air signal supplied to the second connector.

Dot matrix readouts use various arrays of individual indicators. An array of seven groups of dots arranged as shown in Figure 2 provides display of decimal numbers. Each group of dots has a common manifold through which low pressure air drives the indicators to the forward viewing position. The design of the readout incorporates a positive return air pressure which causes retraction from the field of view of those indicators which have no forward drive signal pressure.

Alpha-numeric characters are formed in a 5 x 7 array of indicators. Each indicator is individually driven into the field of view by a separate connection point. Retraction of indicators occurs automatically when air signals are supplied for the next character by a positive pressure buildup at the face of the readout. The alpha-numeric readout of Figure 3 can monitor 35 separate events or circuit conditions. Since each indicator has individual access, it can serve as a very low cost indicator array.

Another version of this readout has a manifold common to all 35 indicators and only two connection points. An array of white or colored indicators corresponding to a fixed character is assembled in the matrix. Application of a low pressure signal to one of the two connections causes the fixed character to appear (Figure 3). A signal on the second connection will establish the blank condition on the readout face.

Size

A considerable latitude in character size is possible with these air driven readouts. The most popular version uses 1/8" diameter pistons which results in character size approximately 1" high and 3/4" wide for a 5 x 7 matrix. Similar versions for 1/16" and 1/4" piston diameters have been built and tested.

Fluid Logic

Fluid logic elements and fluidic circuits closely parallel their electronic counterparts in many aspects. No-moving-part NOR, NAND, AND, OR, and flip-flop fluidic devices are available as discrete elements or as arrays, and integrated circuits of moderate complexity are recent additions to the product catalogues. An integrated circuit assembly is shown in Figure 5 consisting of laminations of fluidic NOR elements and interconnect circuit boards. Two such as-

semblies (FLOWBRIKS) are used in the four decade fluidic prede-termining counter (Figure 6). This unit counts air pulses at rates up to 200 cps and generates the necessary readout drive signals and the predetermined output signal.

Fluidic devices have switching times in the order of 1 millisecond. As such they do not compete with electronics for high speed computing or control markets. Signal propagation in air lines approaches 1 ft./millisecond and this, too, limits the areas of application of fluidic controls. Despite these limitations, fluidic control can provide excellent performance and reliable operation in a vast area of applications in which the switching time or signal delay can be longer than one millisecond. Industrial control generally is in this category. Information display, in many cases is also in this category.

Good contrast requires that the piston retract about two diameters. For large displays (piston diameter ~ 1") it is practical to use an array of small pistons to simulate the action of one large piston. For example, the monitor display of Figure 3, which is 1" x 3/4" can itself be used in a 5 x 7 matrix array to produce characters which are high and 3-3/4" wide (Figure 4).

Viewing Characteristics

The matrix body of the readouts is generally provided with black background; white, colored, or fluorescent pistons are used to form the character. Excellent contrast is achieved between the black background and white or light colored opaque pistons. Less contrast is achieved with dark colored pistons. A white background achieved by making the front surface of the matrix body white and filling all the holes with white pistons. The white pistons are held in normally forward position and are selectively retracted to form characters which appear black on the white background.

The pistons in the forward viewing position are in direct contact with a thin transparent window. This allows for easy readability of the display through a 150° solid angle.

Fluidic / Electric Interfaces

For conversion of electrical signals to air signals, two types of devices are available. Electromechanical devices are used to move a valve or its equivalent resulting in a change in air flow or air pressure. These are moving part devices and are suitable where cyclic rates are low and where extended life is not required. The second type of interface device is an electrofluidic transducer with no moving parts. It uses electrically generated 50 khz sound waves to change the flow in a fluid amplifier. Response times of 2 milliseconds are typical, and the life-time is practically unlimited.

Conversion of fluidic signals to electric signals is commonly done in two general ways. Diaphragm displacement caused by air pressure produces contact closure in one type; the second type uses pressure sensitive transistors or crystals to cause changes in voltage and current in an electronic circuit. The latter devices have the fastest response and the longest life expectancy.

Applications for Air-Operated Display

Listed below are three categories in which air-operated display have an important potential.

	Applications	Advantages
FLUIDIC CONTROL SYSTEMS	1. General Panel Display	1. Excellent Viewing Characteristics
	2. Counters and Sequencers	2. All Air System
	3. System Monitors	3. Excellent Environmental Tolerance
	4. Annunciators	4. Uses Ambient Illumination
ELECTRICAL CONTROL SYSTEMS	General Applications	1. Excellent Viewing Characteristics
		2. New Appearance
		3. Large Size
		4. No Explosion Hazard
		5. No R-F Problems
INFORMATION DISPLAY PANELS, SIGNS	Wall Sized Displays	6. Excellent Environmental Tolerance
		7. Uses Ambient Illumination
		1. Excellent Viewing Characteristics
		2. Large Range of Sizes
		3. Black & White, Colored or Fluorescent
		4. Apparent Motion Attainable
		5. Uses Ambient Illumination
		6. Excellent Environmental Tolerance
		7. Variable Information

POP-UP INDICATOR

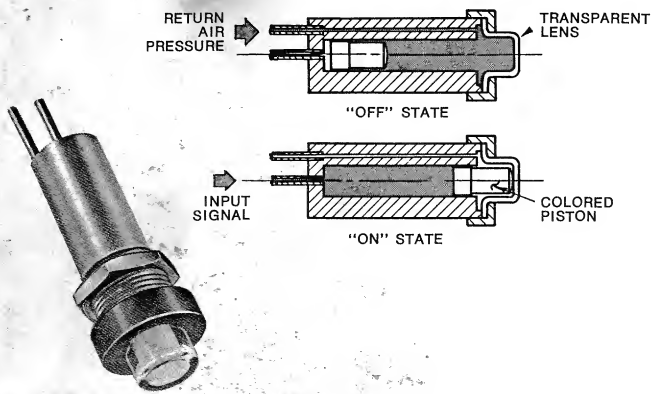


Figure 1

NUMERIC READOUT

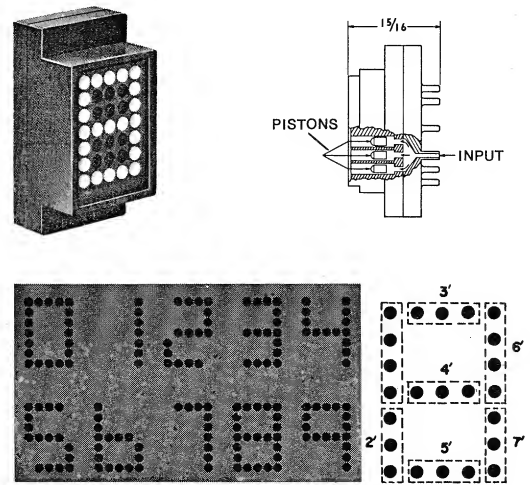
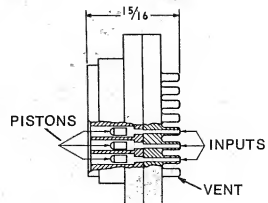


Figure 2

ALPHA NUMERIC READOUT

Variable Character



Single Character

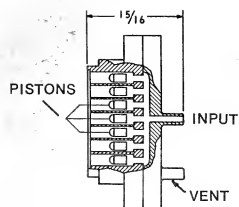


Figure 3

WALL SIZE FLUIDIC DISPLAY



Figure 4

FLOWBRIK Integrated Fluidic Circuit

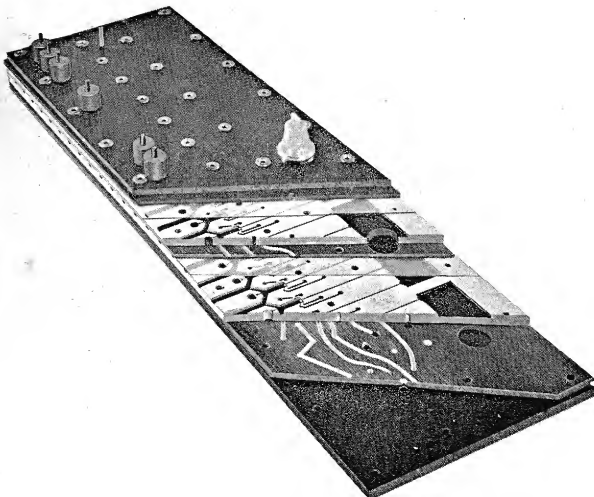


Figure 5

FLUIDIC COUNTER



Figure 6

The products you will need for complete fluidic control systems are available from Pitney-Bowes

The fluidic products described in this publication have been grouped together for your convenience in making comparisons during the selection process. They are a segment of our complete line of compatible standard components. All Pitney-Bowes fluidic controls are designed to operate with one another in systems. No tuning or matching is necessary.

Here is a listing of current standard products and the publications in which application data can be found. Your Pitney-Bowes representative or field engineer can provide additional information.

	Publications	Products
Input Devices Fluidic sensors with unique capabilities and excellent resistance to adverse environments have been developed by Pitney-Bowes. Interface components for introducing information manually or from other signal modes into the fluidic system are also available.	Interruptible Sensors	Opposed Jets Sensor, Emitter-Receiver Diaphragm Sensor, Fluidic Ear
	Proximity Sensors	Back Pressure Sensor, Proximity Sensor, Acoustic Proximity Sensor
	Sensor Relays	2-Way Sensor Relay, 3-Way Sensor Relay
	Panel Operators	Push Button Magnetic Valve, 12-Position Selector
	Electrofluidic Interface	Electrofluidic Transducer, Electrofluidic Pulse Generator
Output Devices The information processed by a fluidic system at low power levels is often used to control substantial amounts of energy. Appropriate outputs are available to do this work. At the same time fluidic readouts allow the display of numbers, letters, symbols or special characters as desired.	Power Amplifiers	Fluidic Power Amplifier 1-4 psig monostable, Fluidic Power Amplifier 1-4 psig bistable, Fluidic Power Amplifier 1-8 psig monostable, Booster 20 to 120 psig, Booster 1 to 20 psig, 3 Sensor Relay
	Information Display	Pop-Up Indicator, Numeric Readout, Alphabetic Readout, Character Readout, Fluidic-Mechanical Counter
	Fluidic-Electric Interface	Fluidic-Electric Miniswitch, Fluidic-Electric Switch
Logic The Pitney-Bowes FLOWBOARD made fluidics practical and economical for industrial controls. It is a versatile, trouble-free way of packaging the NOR logic gates which process control data. FLOWBOARD gates are compatible with one another and with external fluidic components furnished by Pitney-Bowes.	FLOWBOARDS	FLOWBOARD 22, FLOWBOARD 21
	FLOWBRIK Integrated Circuits	STANDARD CIRCUITS: One Decade Decimal Up-Counter with Readout Encoder and Unbuffered Complements, One Decade Decimal Up-Counter with Buffered Outputs, One Decade Decimal Up-Counter with Buffered Complements, Two Decade Decimal Up-Counter with Readout Encoder and Unbuffered Complements, Two Decade Decimal Up-Counter with Buffered Complements, Two Decade Binary Coded Decimal Up-Counter, Two Decade Binary Coded Decimal to 7-Bar Encoder, 3-Stage Binary Coded Decimal to 3-Stage Binary Shift Registers CUSTOM CIRCUITS: Custom circuits to meet specific control requirements may be easily fabricated.
Power Supply The key to achieving the exceptionally high reliability with which fluidic control systems perform in industry is to provide the system with clean, dry air. Pitney-Bowes has developed power supplies that assure contaminant-free air.	Power Supply Components	Dry Air Compressors, Dry Particle Filters, Coalescing Filters, Replacement Filter Cartridges, Pressure Regulators, Pressure Gages.
Packaging Hardware All components needed to assemble a fluidic control system are provided by Pitney-Bowes. Standards for enclosures, arrangement of components and mechanical details have all been worked out to save time, trouble, and cost.	Packaging Hardware	Flotube, Input and Output Connectors, Bulkhead Fittings, Flotube Fittings, Mounting Brackets, Manifolds



Pitney-Bowes
Fluidic Controls
 Research Drive, Glenbrook, Conn. 06906

Converting advanced technology into practical application